British Journal of Anaesthesia **107** (2): 171–9 (2011)
Advance Access publication 2 June 2011 · doi:10.1093/bja/aer148

BJA

Clinical factors associated with the non-utilization of an anaesthesia incident reporting system

G. Haller[1,2,5]*, D. S. Courvoisier[2], H. Anderson[3] and P. S. Myles[3,4]

[1] Department of Anesthesia, Pharmacology and Intensive Care,[2] Division of Clinical Epidemiology, Geneva University Hospitals, University of Geneva, 4, rue Perret-Gentil, 1211 Genève 14, Switzerland
[3] Department of Anaesthesia and Perioperative Medicine, Alfred Hospital, Melbourne
[4] Academic Board of Anaesthesia and Perioperative Medicine, Monash University, Melbourne, Australia
[5] Department of Epidemiology and Preventive Medicine, Monash University, Melbourne, Australia

* Corresponding author. E-mail: guy.haller@hcuge.ch

Editor's key points

- Under-reporting of critical incidents is well known.
- This study shows that the incidents during regional analgesia, emergency procedures, or consultants working alone are less likely to be reported.
- In contrast, longer duration surgery, presence of a trainee, or severe complications prompted better reporting.
- This study highlights important clinical and cultural enablers and barriers to the reporting.

Background. Incident reporting is a widely recommended method to measure undesirable events in anaesthesia. Under-utilization is a major weakness of voluntary incident reporting systems. Little is known about factors influencing reporting practices, particularly the clinical environment, anaesthesia team composition, severity of the incident, and perceived risk of litigation. The purpose of this study was to assess each of these, using an existing anaesthesia database.

Methods. We performed a retrospective cohort study and analysed 46 207 surgical patients. We used multivariate analysis to identify factors associated with the non-utilization of the reporting system.

Results. We found that in 7022 (15.1%) of the procedures performed, the incident reporting system was not used. Factors associated with the non-use of the system were regional anaesthesia/local anaesthesia, odds ratio (OR) 1.64 [95% confidence interval (CI) 1.03–2.62], emergency procedures OR 1.15 (95% CI: 1.05–1.27), and a consultant anaesthetist working without a trainee, OR 1.71 (95% CI: 1.03–2.82). In contrast, factors such as longer duration of surgery, OR 0.85 (95% CI: 0.76–0.94), the presence of a senior anaesthesia trainee, OR 0.86 (95% CI: 0.81–0.92), and the occurrence of severe complications with a high risk of litigation (i.e. death, nerve injuries) were less associated with a non-use of the reporting system, OR 0.65 (95% CI: 0.44–0.97). Team composition and time of day had no measurable impact on reporting practices.

Conclusions. Clinical factors play a significant role in the utilization of an anaesthesia incident reporting system and more particularly, severity of complications and higher liability risks which appear more as incentives than barriers to incident reporting.

Keywords: human factors; incident reporting; patient safety

Accepted for publication: 24 March 2011

Incident reporting has become the most popular and widely recommended method to measure undesirable events associated with hospital care.[1–3] In many countries, anaesthesia professional organizations have made incident reporting a centrepiece of their quality assurance (QA) and patient safety improvement programmes.[4–8] Beyond quality and safety issues, an incident reporting system can be useful in capturing rare events occurring during procedures, or with the introduction of new medications.[9] Accurate recording and systematic reporting of critical events are essential for the full utility of the systems to be realized. This is currently not the case. The utilization of anaesthesia reporting systems varies widely, from 4% to 85%.[10–13]

Little is known about which factors influence utilization of an anaesthesia incident reporting system. A number of studies have shown that education, feedback, safety culture, and the technical design of a reporting system do have an impact on reporting practices in anaesthesia.[14–18] However, key factors that may determine reporting behaviour are the clinical context and aspect of patient care in which reporting takes place. It is currently unknown whether, for instance, time constraints during emergency procedures, complexity of anaesthesia, level of training, or the occurrence of serious and potentially litigious events impact on the use of a reporting system. The purpose of this study was therefore to investigate whether these key aspects of anaesthesia practice had an impact on the use of an incident reporting system in routine practice.

Methods

Setting and data collection tool

The Alfred Hospital (Melbourne, Australia) is an adult university-affiliated hospital, with all types of medical and

specialized surgical services, including neurosurgery, cardiothoracic surgery (including heart and lung transplantation), and a level 1 trauma centre. About 22 000 patients every year are anaesthetized for surgery or another interventional procedure. Before the procedure, appropriate preoperative assessment and examination of the patient is performed by the anaesthetist. Since 1995, we have developed an electronic patient record (EPR) to capture all patient, procedure, and organizational-related information. Data captured include patient characteristics, past medical history and co-morbidities, current functional health status, medication usage, and the ASA physical status score. This is completed during the procedure by the recording of the anaesthesia techniques used, the surgery or interventional procedure undertaken, and the classes of anaesthetic drugs administered. Non-clinical information such as time of the day and week, duration of procedure, emergency status, resident and consultant ID, and supervision level of the anaesthesia registrar/resident ('trainee') are also recorded. The recovery room and 24 h follow-up section is completed after the procedure, during a systematic postoperative follow-up visit performed by an anaesthesia trainee or the QA officer. All anaesthesia-related events (intra- or postoperative) are recorded into the EPR.

The information system also integrates an incident reporting feature for all events occurring during the perioperative period. The form includes one open text and 16 predefined categories of incidents which are defined as *unintended events or outcome which could have, or did reduce the safety margin for the patient.*[19] These predefined categories result from a consensus conference organized in the department of anaesthesia. The form also includes a text box for narratives and a check box 'no incident' which has to be completed when no undesired event has occurred during the intraoperative period (Fig. 1). All medical and QA staff (including consultants) is instructed in the collection of data and also receive a booklet of instructions and item definitions for the completion of the incident section of the EPR. For every procedure, it is mandatory for staff members to fill in the pre- and intraoperative sections of the EPR. The third section (postoperative period) is usually completed by the QA officer or anaesthesiologists completing the daily postoperative follow-up visit. Regular feedback is provided to staff members regarding the overall use of the system. Staff members are also encouraged to provide comments and suggestions for improvement. This is done by the QA officer during personal encounter, usually once a week and during the mortality–morbidity meeting, scheduled every Friday afternoon. During this meeting, incidents are discussed and staff members involved in the process usually describe the sequence of event and suggest a number of corrective strategies to avoid incidents occurring again. Incidents are also analysed outside the mortality–morbidity meeting, as part of the departmental QA programme.

Study design, risk factors, and outcome variable

After institutional ethics approval, we performed a retrospective cohort study using data collected and recorded between April 2002 and June 2006 in the anaesthesia EPR. We included all inpatient and ambulatory procedures performed with an anaesthetist in attendance. Before the analysis, we checked files for double entries and illogical values, using specific structured query language (SQL) clauses. We excluded all double data entries and used logic imputation to correct errors. We recoded and aggregated comorbidities and Australian Medicare procedures into ICD-10-AM category codes using mapping tables to create 13 distinct blocks of surgical intervention, as described previously.[20] Recorded details of the drugs administered and anaesthesia procedures were used to create five categories: general anaesthesia with/without regional nerve block; general anaesthesia with advanced monitoring (i.e. arterial catheter, central venous-line, pulmonary artery catheter); general anaesthesia with blood transfusion; anaesthesia solely with regional nerve block; and sedation with/without combined local or regional anaesthesia. Staff characteristics and team-composition-related factors such as training level or presence of a supervising consultant in theatre were classified according to College (ANZCA) specifications for training and supervision.[4] We also used timing, duration, emergency, and after/late hour status of procedures, to classify some aspects of working conditions. In-hours procedures were those performed between 7:00 a.m. and 6:59 p.m. and after-hours those between 7:00 p.m. and 6:59 a.m. Late-hours procedures were those starting within hours but extending into the after-hours period and associated with day/night shift changes of the anaesthesia team. All procedures during day and night time performed on a non-scheduled basis were defined as emergency procedures. Anaesthesia-related complications identified during the follow-up visit were classified according to a previously described classification scheme into: (i) death, (ii) increased care/risk with irreversible deficit, (iii) increased care/risk with reversible deficit, (iv) increased care/risk without function deficit, and (v) no change in hospital course.[21] To measure risk of liability in anaesthesia-related complications, we performed a broad literature search of anaesthesia-related liability cases in the USA, Australia, Canada, and the UK. We identified all types of undesired anaesthesia-related events which were usually followed by compensation claims.[22–25] According to their reported frequency among claim files, a histogram was built and events were classified into three equal categories: low, intermediate, or high incidence and risk of liability. The few events recorded in our EPR that could not be clearly identified in the literature (i.e. hoarse voice) were discussed with a second consultant anaesthetist and classified following consensus. The no-risk and low liability risk categories were aggregated.

To measure the non-use of the incident reporting system, we developed a combined outcome which integrated both the 'no incident' variable and the 16 different categories of predefined incidents variables of the EPR. Non-utilization of the reporting system was defined as a missing value in all the 16 predefined categories of incidents and in the 'no incident' field of the patient record (either an incident has occurred or not).

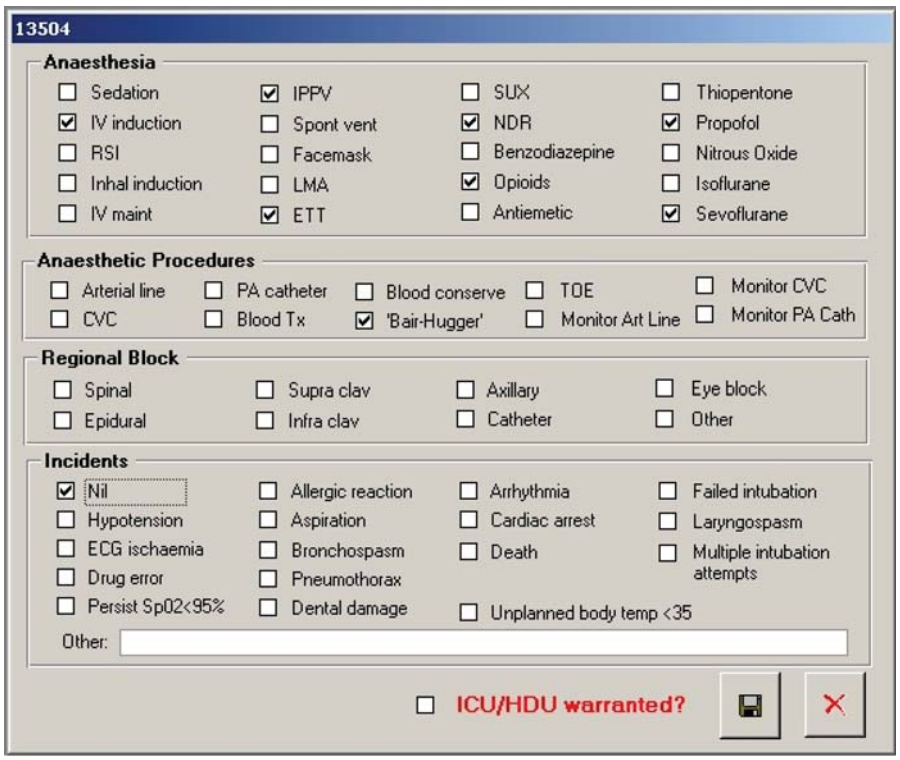

Fig 1 Incident reporting form.

Statistical analysis

For descriptive analysis, we used frequencies and percentages. Continuous variables such as age and time of surgery were transformed into separate and mutually exclusive categories; ASA IV and V categories were aggregated. Surgical procedures were described according to the ICD-10-AM main category codes. Training level from year 1 to 5 was aggregated into two main categories, basic training for year 1 and 2, advanced training for year 3–5. Team composition was determined according to supervision level of trainees: category 1 for one consultant working and supervising one anaesthesia trainee in the same operating theatre; category 2 for one consultant working and supervising several anaesthesia trainees in different operating theatres; and category 3 for one consultant working and supervising several anaesthesia trainees in different operating theatres but who was not present in the immediate area but readily available. Anaesthesia-related complications were aggregated into three main categories: (i) severe followed by death or permanent disability within 24 h; (ii) reversible deficit with change in postoperative hospital course; and (iii) reversible deficit with no change in postoperative hospital course.

We first performed a univariate analysis comparing all patients, procedures, working conditions, staff, and complication-related factors during operations with and without use of the incident reporting system. χ^2, Fisher's exact test, or binary logistic regression was used, and derived odds ratio (OR) with 95% confidence interval (CI) calculated to assess differences between the groups. An OR >1.0 indicates a reduced risk of non-utilization, and thus represents a greater likelihood of compliance with EPR reporting. To identify independent risk factors for non-utilization, we performed multivariate analyses using logistic regression. We built multivariate models using a forward selection technique, considering only univariate risk factors with a *P*-value of <0.10 and expected count of at least 5 in the contingency tables. Variables that were still significant at $P<0.1$, or that had strong clinical significance (age, type of anaesthesia, team composition) were retained. An interaction term was created and introduced into the model to account for the interaction phenomenon between ASA score and the type of anaesthetic procedure performed. To model the interaction effect between training level and team composition, we performed a stratified analysis. As collinearity was diagnosed between after-hour and emergency procedure, only the latter was retained in the final model. The significance of the Hosmer–Lemeshow goodness-of-fit test was 0.26.[26] Final results are expressed as adjusted 95% CI and *P*-values. A *P*-value of <0.05 was considered statistically significant. We used the Statistical Package for Social Sciences, SPSS (Version 17, SPSS Inc., Chicago, IL, USA) for all analyses.

Results

After data retrieval of 48 983 patients, we excluded 2776 (5.6%) patients for double data entries and missing patient characteristic and procedure-related information. The final study cohort included 46 207 patients who had an anaesthetic procedure during the study period and were further analysed.

In 7022 (15.1%) cases, we found non-utilization of the incident reporting system during the anaesthesia, for which univariate correlates are presented in Table 1. Significant factors include patient age, known (previous) anaesthetic risk factors, hypertension and coronary artery disease, ASA physical status, and some surgical procedures and types of anaesthesia (Table 1).

After adjusting for the influence of patient age, comorbidities, anaesthetic risk, and type of surgery on the choice of the anaesthesia technique used, on the working context and anaesthesia team composition, most risk factors and associations identified in the univariate analysis were confirmed (Table 2). More complex anaesthesia, indicated by the use of advanced monitoring or blood transfusion, when compared with regional anaesthesia or sedation procedures, had reduced non-utilization, OR 0.57 (95% CI: 0.51–0.64) and 0.62 (95% CI: 0.52–0.74), respectively. Similarly, during intermediate (>65 min) and long procedures (>120 min), it had reduced non-utilization, OR 0.81 (95% CI: 0.74–0.88) and 0.85 (95% CI: 0.76–0.94), respectively, both $P<0.001$ (Table 2).

The working context had no impact except for emergency procedures, adjusted OR 1.15 (95% CI: 1.05–1.27). Multivariate analysis also confirmed that seniority of trainees was a protective factor for non-use, OR 0.86 (95% CI: 0.81–0.92). This difference was unaffected by the presence or absence of a consultant anaesthetist in the same theatre (Fig. 2). However, when consultants worked on their own, they were more likely to not use the reporting system, OR 1.71 (95% CI: 1.03–2.82).

When severe complications with a potential risk (low, intermediate, or high) for litigation had occurred, the reporting system was more likely to be used, OR for non-use 0.54 (95% CI: 0.30–0.99) to 0.75 (95% CI: 0.61–0.93), depending on incident types (Table 3).

Discussion

We found that clinical aspects of everyday anaesthetic practice had a significant impact on incident reporting behaviour. Increased complexity of anaesthetic procedures performed, duration of surgery, seniority of trainees, and the presence of anaesthesia-related complications with a higher risk of litigation were associated with greater use of the reporting system. In contrast, emergency procedures or those performed by consultants with no trainee in theatre were associated with less use of the reporting system. Weekend, night time, or prolonged after-hour periods did not impact on reporting practices.

Only a few studies have explored the influence of clinical factors on reporting practices in anaesthesia. In one series of 734 reported incidents, authors did not find any impact of patient clinical condition and severity of outcome on the rate of reporting.[21] In a survey of Canadian anaesthetists, workload was frequently identified as a barrier to voluntary reporting.[27] In contrast, in our study, we found that increased workload (general anaesthesia with advanced monitoring or blood transfusion) and the presence of a significant complication were rather an incentive than a barrier to incident reporting. These discrepancies may be explained by differences in study methodology. In our study, as the non-utilization of the incident reporting system could be tracked electronically, we were able to capture a large number of events which significantly increased our study power and the likelihood to detect differences among groups. Also, we did not perform any staff survey or peer review process of anaesthesia procedures and we relied on EPRs exclusively. Beyond these differences, it is interesting to understand why straightforward anaesthetic and surgical procedures in ASA I or II patients discouraged anaesthetists from using the incident reporting system. There may be several explanations. One is that the type and characteristics of incidents occurring during such procedures (i.e. hypotension, transitory respiratory arrest) may not be considered by anaesthetists as warranting a report. Previous studies have shown that minor anaesthetic incidents are usually not reported or incompletely reported, as opposed to more major ones.[28] Another possible explanation may be the shorter duration of uncomplicated procedures in ASA I and II patients which result in a major shift of the workload towards induction and emergence-related activities rather than monitoring and recording activities. Previous studies have shown that the proportion of time allocated to completing a patient record during an anaesthetic procedure represents about 10–12% of the overall activity and this occurs mostly during the intraoperative period when vigilance and attention to abnormal variations is higher.[29–31] This may also explain why we found that the likelihood of not using the reporting system during ultra-short procedure compared with intermediate (>65 min) or long procedures (>120 min) was higher.

Another finding from our study is that junior trainees were less likely to use the reporting system. Similar findings have been previously published in non-anaesthetic settings.[32 33] Fear of blame by senior staff may be a factor.[34] However, we also found, in the multivariate analysis, that consultants working on their own were less likely to use the reporting system. This was unexpected and in contrast to existing literature.[32 33] One possible explanation is that consultants working on their own without being involved in trainee supervision activities were too busy (providing anaesthesia care) or were more likely to ignore reporting responsibilities without an immediate responsibility of mentorship. Maybe senior/experienced anaesthetists have a different perspective, and attach little significance to minor incidents as they view them innocuous. It is also possible that consultants have lost the systematic habit of reporting incidents, as in many

Table 1 Patient, surgical procedure, and anaesthetist characteristics and univariate risk factors for non-utilization of the incident reporting system. The data are *n* (%). *For χ^2 test and Fisher's exact test for values <5. †*P*-value for χ^2 test for linear trend

Risk factors	Non-utilization (*n*=7022)	Utilization (*n*=39 185)	OR (95% CI)	*P*-value*
Patient characteristics				
Age				
<41 yr	2268 (32.3)	12 854 (32.8)	1 (reference)	0.03†
41–64 yr	2231 (31.8)	12 874 (32.9)	0.98 (0.92–1.05)	
>64 yr	2523 (35.9)	13 453 (34.3)	1.06 (1.00–1.13)	
Sex : male	4022 (57.3)	22 403 (57.2)	1.00 (0.95–1.06)	0.87
Comorbidities				
Diabetes	249 (3.5)	1521 (3.9)	0.91 (0.79–1.04)	0.18
Past anaesthetic problems	139 (2.0)	770 (2.0)	1.01 (0.84–1.21)	0.94
Current anaesthetic risks (difficult intubation, etc)	567 (8.1)	4193 (10.7)	0.73 (0.67–0.80)	<0.001
Obesity	215 (3.1)	1354 (3.5)	0.88 (0.76–1.02)	0.09
Cognitive dysfunction or coma	507 (7.2)	3562 (9.1)	0.78 (0.71–0.86)	<0.001
Hypertension	1515 (21.6)	9437 (24.1)	0.87 (0.82–0.92)	<0.001
Ischaemic heart disease	960 (13.7)	5907 (15.1)	0.89 (0.83–0.96)	0.002
Other heart disease (including valvular, heart failure)	364 (5.2)	2219 (5.7)	0.91 (0.81–1.02)	0.11
Cerebrovascular disease	236 (3.4)	1466 (3.7)	0.90 (0.78–1.03)	0.12
Chronic respiratory disease	631 (9.0)	3836 (9.8)	0.91 (0.83–0.99)	0.04
Current smoker	665 (9.5)	3934 (10.0)	0.94 (0.86–1.02)	0.14
HIV positive	96 (1.4)	531 (1.4)	1.01 (0.81–1.26)	0.94
ASA physical status				
I	1775 (25.3)	10 352 (26.4)	1 (reference)	<0.001†
II	2620 (37.3)	13 653 (34.8)	1.12 (1.05–1.20)	
III	2018 (28.7)	10 923 (27.9)	1.08 (1.01–1.16)	
IV	574 (8.2)	3993 (10.2)	0.84 (0.76–0.93)	
V–VI	35 (0.5)	264 (0.7)	0.77 (0.54–1.10)	
Procedure characteristics				
Surgical procedure				
Dermatologic and plastic procedures	794 (11.3)	3647 (9.3)	1 (reference)	<0.001
On nervous system	366 (5.2)	2033 (5.2)	1.12 (0.95–1.33)	
On eye and adnexae	191 (2.7)	585 (1.5)	2.04 (1.65–2.51)	
On ear and mastoid	130 (1.9)	817 (2.1)	0.99 (0.79–1.24)	
On nose, mouth, and pharynx	339 (4.8)	2221 (5.7)	0.95 (0.80–1.13)	
On respiratory system	152 (2.2)	792 (2.0)	1.20 (0.97–1.49)	
On cardiovascular system	424 (6.0)	3253 (8.3)	0.81 (0.69–0.96)	
On blood and blood-forming organs	4 (0.1)	50 (0.1)	0.50 (0.18–1.39)	
On digestive system	1726 (24.6)	9673 (24.7)	1.11 (0.97–1.28)	
On urinary system and genital organs	403 (5.7)	2116 (5.4)	1.19 (1.01–1.41)	
On female genital organs and breast	420 (6.0)	2584 (6.6)	1.01 (0.86–1.20)	
On musculoskeletal system	1805 (25.7)	9742 (24.9)	1.16 (1.01–1.33)	
Invasive, cognitive diagnostic	268 (3.8)	1672 (4.3)	1.36 (1.17–1.58)	
Anaesthetic procedure				
General anaesthesia (with or w/o local/regional)	5276 (75.1)	30 761 (78.5)	0.83 (0.78–0.88)	<0.001
General anaesthesia with advanced monitoring)	1007 (14.3)	8620 (22.0)	0.59 (0.55–0.64)	<0.001
General anaesthesia with blood transfusion)	196 (2.8)	2407 (6.1)	0.43 (0.37–0.50)	<0.001
Only local/regional	357 (5.1)	1630 (4.2)	1.23 (1.10–1.39)	<0.001
Sedation (with or w/o local/regional)	1389 (19.8)	6794 (17.3)	1.18 (1.10–1.25)	<0.001

Continued

Table 1 *Continued*

Risk factors	Non-utilization (*n*=7022)	Utilization (*n*=39 185)	OR (95% CI)	*P*-value*
Duration of procedure				
Ultra short (<35 min)	1988 (28.3)	9581 (24.5)	1.0(reference)	<0.001
Short (36–64 min)	1978 (28.2)	10179 (26.0)	0.93 (0.87–1.00)	
Intermediate (65–120 min)	1553 (22.1)	9426 (24.1)	0.79 (0.73–0.85)	
Long (>120 min)	1503 (21.4)	9999 (25.5)	0.72 (0.67–0.77)	
Timing and planning of procedures				
In-hours (07:00–C)	6199 (88.3)	34 630 (88.4)	1.0(reference)	<0.35
Late hours (from 07:00 to 18:59)	191 (2.7)	1160 (3.0)	0.92 (0.78–1.08)	
After hours	632 (9.0)	3386 (8.6)	1.04 (0.95–1.14)	
Weekend procedure	609 (8.7)	3387 (8.6)	1.00 (0.91–1.09)	
Emergency procedure	1330 (18.9)	7690 (19.6)	0.96 (0.90–1.02)	
Physician characteristics				
Seniority				
Registrar: basic training	3517 (50.1)	17 660 (45.1)	1 (reference)	<0.001
Registrar: advanced training	1765 (25.7)	10 074 (25.1)	0.88 (0.83–0.94)	
Consultant	1737 (24.7)	11 442 (29.2)	0.76 (0.72–0.81)	
Level of supervision (among registrars)				
Consultant with one registrar	3652 (68.8)	19 425 (69.9)	1 (reference)	<0.19
Consultant supervising several registrars (and in theatre suite)	423 (8.0)	2247 (8.1)	1.00 (0.90–1.12)	
Consultant with several registrars (but outside theatre suite)	1231 (23.2)	6133 (22.1)	1.07 (1.00–1.15)	
Severity of anaesthesia-related complications				
No change in hospital course	954 (86.1)	5073 (81.9)	1 (reference)	0.002
Reversible deficit with change in hospital course	137 (12.4)	970 (15.7)	0.75 (0.62–0.91)	
Death or irreversible deficit	17 (1.5)	154 (2.5)	0.58 (0.35–0.97)	
Risk of litigation after complication				
Absent	952 (85.9)	5047 (81.4)	1 (reference)	0.002
Intermediate or low	122 (11.0)	894 (14.4)	0.72 (0.59–0.88)	
High	34 (3.1)	256 (4.1)	0.70 (0.48–1.01)	

cases of supervision 2 or 3, trainees are the ones in charge of performing the intraoperative data collection process.

We also found that the level of consultant supervision had no impact on reporting practices. In our hospital, there are regular educational sessions scheduled once a week that include mortality and morbidity review in a transparent, blame-free, and instructive environment. As a result, there is strong encouragement for incident reporting and enhancement of a departmental safety culture occurs largely outside theatre rather than when procedures are performed.

Finally, our study results showed that perceived risk of litigation was rather an incentive than a barrier to the use of a voluntary incident reporting system. There are several possible explanations for this. First, undesirable events with a high likelihood of patient or family compensation claims are often those which are the most visible (e.g. dental injury, intraoperative death, brain damage). As a result, they may be perceived as clearly warranting reporting more than complications with low impact and visibility (e.g. transitory vomiting). Secondly, incidents with high or intermediate risk of compensation claims are also more likely to attract the scrutiny of peers and other hospital staff. Reporting these events may be viewed as a way to emphasize one's 'state of the art' professional attitude and behaviour.[2 35] Patient safety experts agree that to improve one's clinical practice, we must audit and respond to unexpected incidents.[2] There is little doubt that a supportive legal environment that protects the reporter–clinician (or hospital) aids this process.[23 24 27] There is a strong view that these reports have had an educational impact and decreased the risk of litigation arising from incidents involving anaesthetists.[21 36]

A number of limitations of this study should be considered. This was a single-centre study. Therefore, it is unclear whether our findings reflect more the local reporting culture than customary behaviour of anaesthetists throughout the world. As incidents are openly discussed in the department during Friday afternoon meetings, this may reinforce local safety culture. However, many of our findings are similar to those identified in other studies, countries, and

Table 2 Adjusted anaesthesia-related factors associated with the non-utilization of the incident reporting system. *An OR <1.0 indicates a reduced risk of non-utilization, and is adjusted for patient age, comorbidities, ASA score, and its interaction with type of anaesthesia and category of surgical procedure

Risk factor	OR (95% CI)*	*P*-value
Anaesthesia procedure characteristics		
General anaesthesia (with or w/o local/regional)	1.41 (0.90–2.22)	0.12
General anaesthesia with advanced monitoring)	0.58 (0.51–0.64)	<0.001
General anaesthesia with blood transfusion)	0.62 (0.52–0.74)	<0.001
Only local/regional	1.64 (1.03–2.62)	0.03
Sedation (with or w/o local/regional)	1.84 (1.17–2.89)	0.008
Duration of procedure		
Brief (<35 min)	1.0 (reference)	<0.001
Short (36–64 min)	0.88 (0.80–0.95)	
Intermediate (65–120 min)	0.81 (0.74–0.88)	
Long (>120 min)	0.85 (0.76–0.94)	
Timing and planning of procedures		
In-hours (07:00–18:59)	0.91 (0.81–1.02)	0.11
Late hours (from 07:00 to >18:59)	1.02 (0.84–1.25)	0.78
Emergency procedure	1.15 (1.05–1.27)	0.003
Weekend procedure	1.03 (0.92–1.16)	0.52
Physician characteristics		
Seniority		
Registrar: basic training	1	<0.001
Registrar: advanced training	0.86 (0.81–0.92)	
Consultant	1.71 (1.03–2.82)	
Team composition		
Consultant with one registrar	1	1.0
Consultant supervising several registrars (and in theatre suite)	0.94 (0.83–1.06)	0.36
Consultant with several registrars (but outside theatre suite)	0.91 (0.84–0.99)	0.03
Severity of anaesthesia-related complications		
No change in hospital course	1	<0.001
Reversible deficit with change in hospital course	0.75 (0.61–0.93)	
Death or irreversible deficit	0.54 (0.30–0.99)	

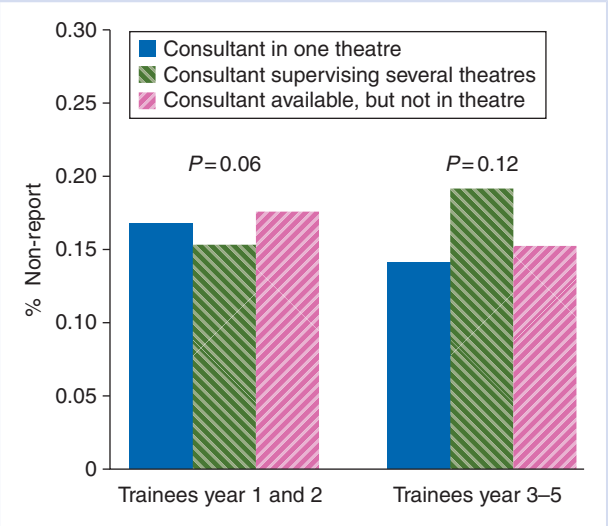

Fig 2 Stratified analysis for non-reporting according to team composition and seniority of trainees. *P*-value for differences in supervision level.

Table 3 Litigation risk and non-utilization of the incident reporting system. *An OR <1.0 indicates a reduced risk of non-utilization, and is adjusted for patient age, ASA score, type of surgery and anaesthesia, supervision level, seniority of trainees, and emergency status

	OR (95% CI)*	*P*-value
Litigation risk		
Absent	1.0	<0.001
Intermediate or low	0.67 (0.54–0.83)	
High	0.65 (0.44–0.97)	

hospitals[12 20] supporting the generalizability of our study conclusions. As we performed a retrospective study on existing data, a number of variables not included in the initial data collection system could not be analysed. These include light, noise conditions, and a number of other human factors which may significantly impact on reporting

rate but were not captured in our study.[37] We may have missed a number of situations where incidents may have been disclosed and discussed during mortality–morbidity meetings without being systematically recorded into the reporting system, thus over-estimating the level of under-utilization of the system. We also used as a measure of non-reporting, the use or non-use of the system. We were unable, as we did not use a gold standard (i.e. medical record review; direct observation) to confirm the true presence or absence of incidents during procedures. It is therefore unclear whether the reporting system was not used because there was no incident occurrence or whether anaesthetists were unwilling to disclose a preventable incident. We based our classification of litigation risk on a rigorous literature search; however, these are only likelihoods not certainty. Despite these limitations, our findings question the common view that healthcare professionals fear litigation and hide adverse events. They remind us that incidents are facts, not judgements, and there should be no danger that incident reporting will increase litigation risk.

To our knowledge, this is the first study using a quantitative approach to measure clinical factors associated with the non-use of a reporting system in an area where evidence relies on qualitative studies and empirical surveys. Future research should look at designing a prospective study using direct observation in the operating theatre to identify more systematically human factors associated with the non-use of incident reporting systems.[38] The combination of physician surveys and direct observation could also be performed and results compared in order to determine mismatches between stated and real reporting practices. This should contribute to the better understanding of how incident reporting systems are used in anaesthesia, a crucial aspect for anaesthesia development.

In conclusion, under-utilization is a major weakness of voluntary incident reporting systems in all healthcare disciplines. Clinical factors associated with the practice of anaesthesia can explain some of this phenomenon. While increased complexity of anaesthetic procedures performed, duration of surgery, and seniority of trainees improve the use of the reporting system, time constraints and unfamiliarity with the system represent significant obstacles to reporting.

Conflict of interest

None declared.

Funding

University of Geneva postgraduate scholarship (for G.H.). P.S.M. is supported by an Australian National Health and Medical Research Council Practitioner's Fellowship. The authors' work was independent of the funders.

References

1 Farley DO, Haviland A, Champagne S, *et al.* Adverse-event-reporting practices by US hospitals: results of a national survey. *Qual Saf Health Care* 2008; **17**: 416–23

2 Runciman WB. Lessons from the Australian Patient Safety Foundation: setting up a national patient safety surveillance system—is this the right model? *Qual Saf Health Care* 2002; **11**: 246–51

3 Shaw R, Drever F, Hughes H, Osborn S, Williams S. Adverse events and near miss reporting in the NHS. *Qual Saf Health Care* 2005; **14**: 279–83

4 Australian New Zealand College of Anaesthetists. Professional standards (PS6): the anesthesia record:recommendations on the recording of an episode of anaesthesia care. Available from www.anzca.edu.au (accessed June 6, 2010)

5 American Society of Anesthesiologists, Cohen J. *Manual for Anesthesia Department Organization and Management*. Park Ridge: American Society of Anesthesiologists, 2003

6 Royal College of Anaesthetists; The Association of Anaesthetists of Great Britain and Ireland. *Good Practice: A Guide for Departments of Anaesthesia, Critical Care and Pain Management*. Professional Standards Directorate, 2006. Available from http://www.rcoa.ac.uk/docs/goodpractice(oct2006).pdf (accessed June 6, 2010)

7 Punjasawadwong Y, Suraseranivongse S, Charuluxananan S, *et al.* Multicentered study of model of anesthesia related adverse events in Thailand by incident report (the Thai Anesthesia Incident Monitoring Study): methodology. *J Med Assoc Thai* 2007; **90**: 2529–37

8 Staender S, Davies J, Helmreich B, Sexton B, Kaufmann M. The anaesthesia critical incident reporting system: an experience based database. *Int J Med Inform* 1997; **47**: 87–90

9 Barach P, Small SD. Reporting and preventing medical mishaps: lessons from non-medical near miss reporting systems. *Br Med J* 2000; **320**: 759–63

10 Ayanian JZ, Landrum MB, Normand SL, Guadagnoli E, McNeil BJ. Rating the appropriateness of coronary angiography—do practicing physicians agree with an expert panel and with each other? *N Engl J Med* 1998; **338**: 1896–904

11 Haller G, Myles PS, Stoelwinder J, Langley M, Anderson H, McNeil J. Integrating incident reporting into an electronic patient record system. *J Am Med Inform Assoc* 2007; **14**: 175–81

12 Jayasuriya JP, Anandaciva S. Compliance with an incident report scheme in anaesthesia. *Anaesthesia* 1995; **50**: 846–9

13 Sanborn KV, Castro J, Kuroda M, Thys DM. Detection of intraoperative incidents by electronic scanning of computerized anesthesia records. Comparison with voluntary reporting. *Anesthesiology* 1996; **85**: 977–87

14 Bent PD, Bolsin SN, Creati BJ, Patrick AJ, Colson ME. Professional monitoring and critical incident reporting using personal digital assistants. *Med J Aust* 2002; **177**: 496–9

15 Mahajan RP. Critical incident reporting and learning. *Br J Anaesth* 2010; **105**: 69–75

16 Yong H, Kluger MT. Incident reporting in anaesthesia: a survey of practice in New Zealand. *Anaesth Intensive Care* 2003; **31**: 555–9

17 Benson M, Junger A, Fuchs C, *et al.* Using an anesthesia information management system to prove a deficit in voluntary reporting of adverse events in a quality assurance program. *J Clin Monit Comput* 2000; **16**: 211–7

18 Bolsin S, Solly R, Patrick A. The value of personal professional monitoring performance data and open disclosure policies in anaesthetic practice: a case report. *Qual Saf Health Care* 2003; **12**: 295–7

19 Runciman WB, Sellen A, Webb RK, *et al.* The Australian Incident Monitoring Study. Errors, incidents and accidents in anaesthetic practice. *Anaesth Intensive Care* 1993; **21**: 506–19

20 National Centre for Classification in Health (Sydney NSW). *Icd-10-Am: The International Statistical Classification of Diseases and Related Health Problems*, 10th revision, Australian modification. Lidcombe, NSW: National Centre for Classification in Health, 2000

21 Katz RI, Lagasse RS. Factors influencing the reporting of adverse perioperative outcomes to a quality management program. *Anesth Analg* 2000; **90**: 344–50

22 Aitkenhead AR. The pattern of litigation against anaesthetists. *Br J Anaesth* 1994; **73**: 10–21

23 Cass NM. Medicolegal claims against anaesthetists: a 20 year study. *Anaesth Intensive Care* 2004; **32**: 47–58

24 Cheney FW, Posner K, Caplan RA, Ward RJ. Standard of care and anesthesia liability. *J Am Med Assoc* 1989; **261**: 1599–603

25 Peng PW, Smedstad KG. Litigation in Canada against anesthesiologists practicing regional anesthesia. A review of closed claims. *Can J Anaesth* 2000; **47**: 105–12

26 Hosmer DW, Lemeshow S. *Applied Logistic Regression*. New York: Wiley, 2000

27 Merchant RN, Gully PM. A survey of British Columbia anesthesiologists on a provincial critical incident reporting program. *Can J Anaesth* 2005; **52**: 680–4

28 Smith AF, Goodwin D, Mort M, Pope C. Adverse events in anaesthetic practice: qualitative study of definition, discussion and reporting. *Br J Anaesth* 2006; **96**: 715–21

29 Byrne AJ, Sellen AJ, Jones JG. Errors on anaesthetic record charts as a measure of anaesthetic performance during simulated critical incidents. *Br J Anaesth* 1998; **80**: 58–62

30 Loeb RG. Monitor surveillance and vigilance of anesthesia residents. *Anesthesiology* 1994; **80**: 527–33

31 McDonald JS, Dzwonczyk R, Gupta B, Dahl M. A second time-study of the anaesthetist's intraoperative period. *Br J Anaesth* 1990; **64**: 582–5

32 Kaldjian LC, Jones EW, Wu BJ, Forman-Hoffman VL, Levi BH, Rosenthal GE. Reporting medical errors to improve patient safety: a survey of physicians in teaching hospitals. *Arch Intern Med* 2008; **168**: 40–6

33 Sweis D, Wong IC. A survey on factors that could affect adverse drug reaction reporting according to hospital pharmacists in Great Britain. *Drug Saf* 2000; **23**: 165–72

34 Vincent C, Stanhope N, Crowley-Murphy M. Reasons for not reporting adverse incidents: an empirical study. *J Eval Clin Pract* 1999; **5**: 13–21

35 Leape LL. Reporting of adverse events. *N Engl J Med* 2002; **347**: 1633–8

36 Cheney FW. The American Society of Anesthesiologists Closed Claims Project: what have we learned, how has it affected practice, and how will it affect practice in the future? *Anesthesiology* 1999; **91**: 552–6

37 Weinger MB, Englund CE. Ergonomic and human factors affecting anesthetic vigilance and monitoring performance in the operating room environment. *Anesthesiology* 1990; **73**: 995–1021

38 Andrews LB, Stocking C, Krizek T, *et al.* An alternative strategy for studying adverse events in medical care. *Lancet* 1997; **349**: 309–13